Autonomous Underwater Vehicles
Explorer Class

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Why use an AUV?

Autonomous Underwater Vehicles (AUVs) provide a means to do a wide array of research in the oceans and in hazardous underwater environments.

Advantages:

- Versatility to deploy a wide range of sensor payloads
- Ability to send the vehicle to remote locations that cannot be accessed with a tether or link to the surface – ice
- Autonomous missions, extensive survey, no back-up ship - unescorted
- Measurements at accurate 3-D spatial locations
- High potential for ocean environmental monitoring

Issues for users: personnel; funding; insurance; safety/operation; environmental effects

MUN Explorer AUV

The *MUN Explorer AUV*, built by ISE Ltd., delivered July 2006.

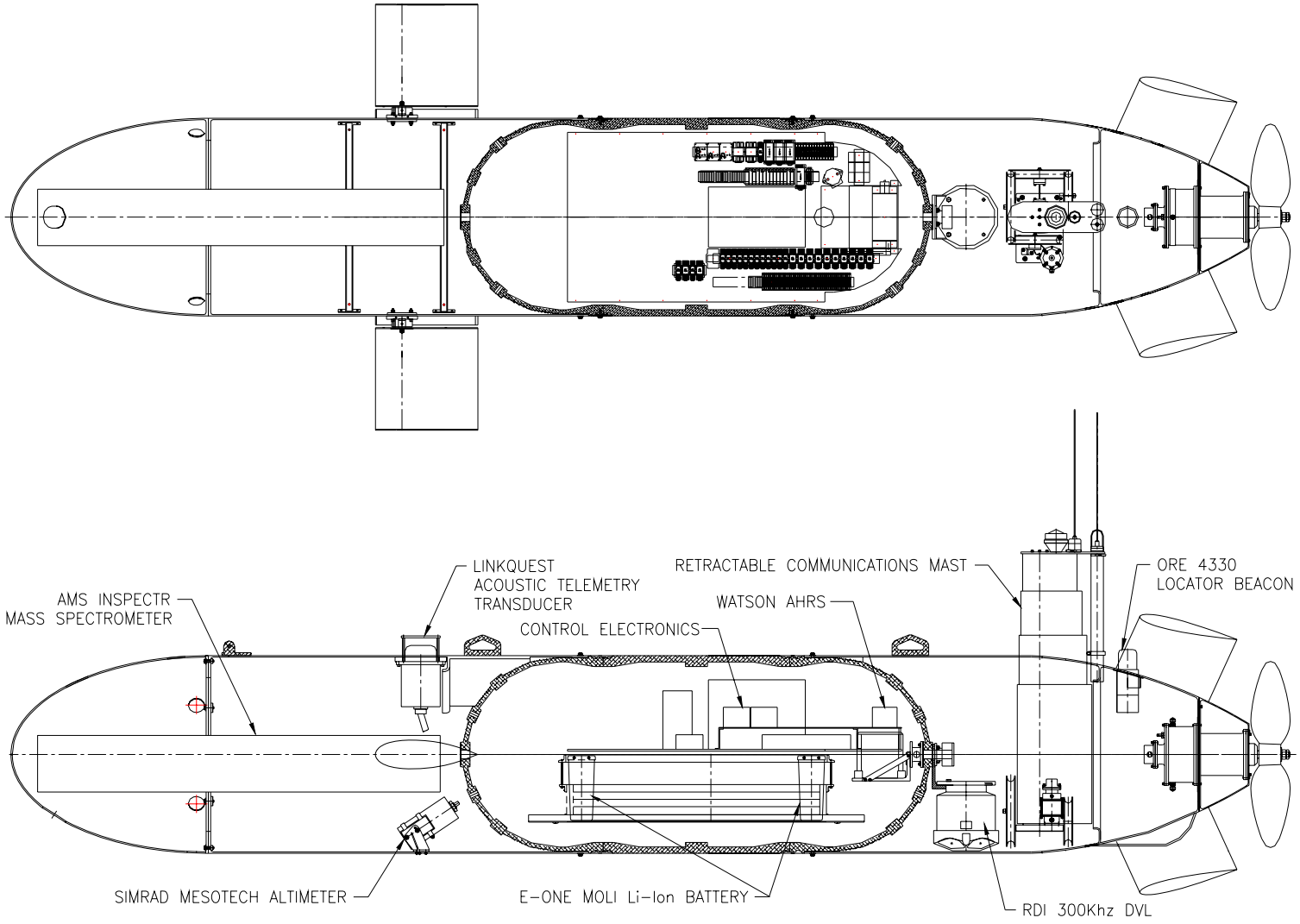
Missions complete

- Dynamics of vehicle, circles, zig zags (vert. and hor.)
- Plume discharge (CTD + fluorometer) – 2006 simulated discharge; 2007 sewage outfall Spaniard's Bay, NL; Biosonics sonar Placentia Bay

Multi-user vehicle whose primary use is for research missions

Neil Bose – Canada Research Chair in Offshore and Underwater Vehicles Design to 2007

Dan Walker – Team Leader 2007-



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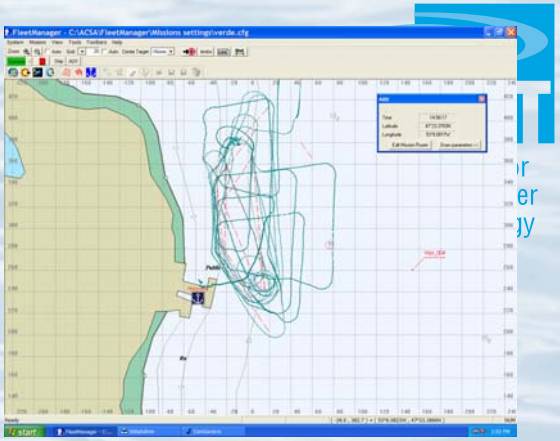
Research - Memorial



Offshore environmental risk engineering

- Ocean environmental impacts of planned discharges from the offshore oil and gas industry (produced water and drilling cuttings)

AUV use as ocean environmental monitoring tool

Biosonics fisheries echo sounder for seabed categorisation – DFO/Anderson

Potential

- Science missions under polar sea ice
- Seabed imaging

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Research Tasmania: engineering & science focus - 2008-2010

Extend AUV capability – e.g. operations under sea ice.

- Prelude to science missions from the *Aurora Australis* in conjunction with researchers at ACECRC.
- Development of under ice profiling and obstacle avoidance, homing, positioning and potential recovery under ice.

Open ocean survey at several depths - fisheries echo sounders

Demonstration missions – e.g. effectiveness of instrumentation; un-escorted coastal; maritime security

Training of AMC *Bluefin* staff in AUV operations at sea from a surface vessel.

Antarctic mission 2010

Tony Worby, ACECRC, UTAS. Project title: Physical and biological processes associated with early season (April-May) sea ice growth processes and ice edge location

- relative importance of dynamic versus thermodynamic processes in determining the location of the sea ice edge;
- mechanisms by which algae are incorporated into sea ice during ice growth and the effects on ice algal physiology;
- role of the autumn sea-ice edge as krill habitat using AUV mounted sonar;
- large-scale ice and snow thickness distribution of the study region;
- temporal evolution of physico-chemical and biological properties of newly forming/young sea ice;
- conduct AUV and aircraft-based measurements for validation of Cryosat II radar altimetry data over Antarctic sea ice.

Partners in Antarctic missions

- AMC/UTAS, Tasmania
- Memorial University, Canada
- Antarctic, Climate and Ecosystems CRC and Australian Antarctic Division
- Underwater Systems – IFREMER, France
- International Submarine Engineering Ltd., Canada
- University of Southern Mississippi, USA
- National Oceanography Centre, UK

Capability - Imaging with Explorer

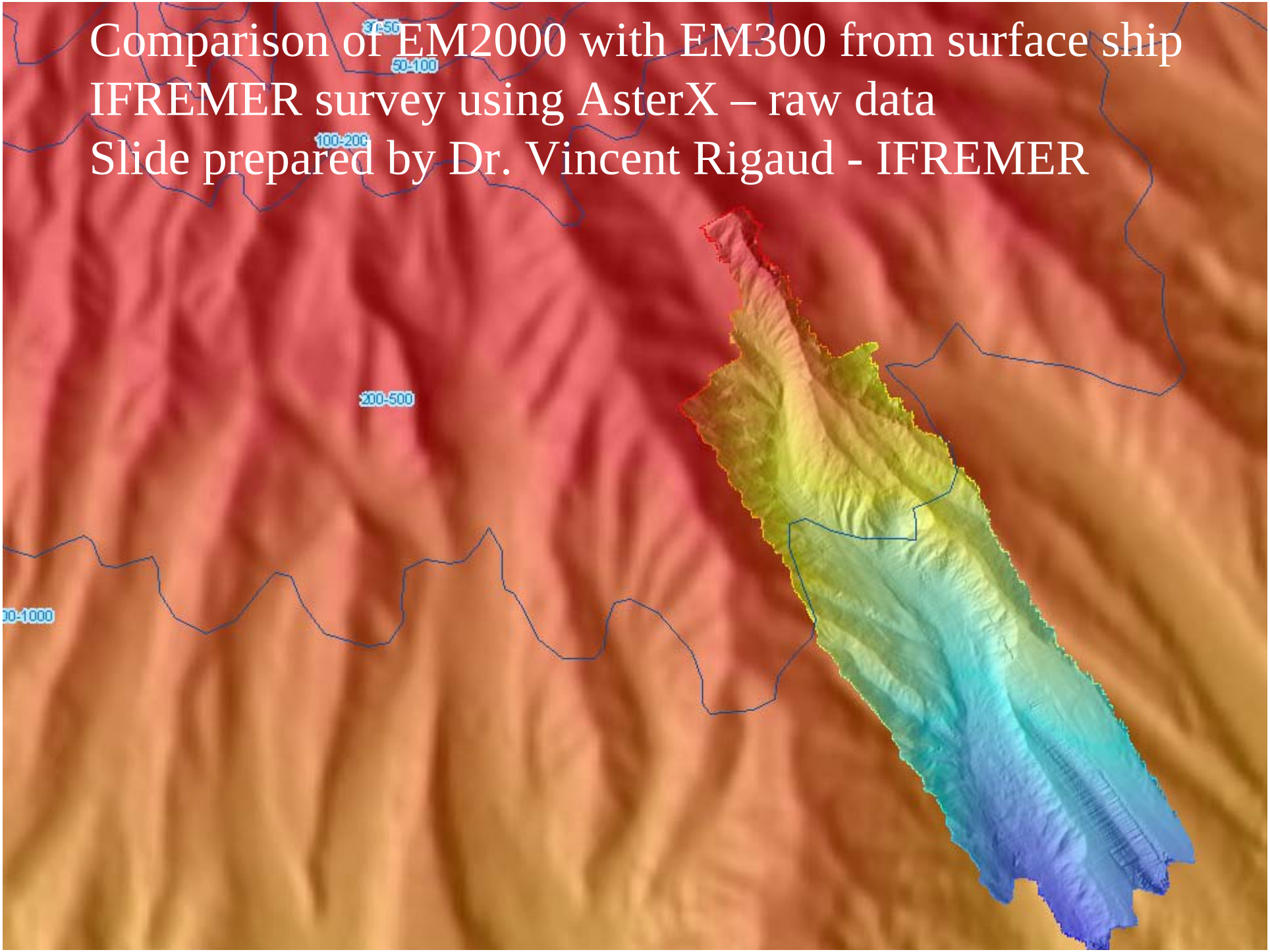
Equipment:

- Multibeam echo-sounder – e.g. Kongsberg/Simrad EM2000E; Imagenex
- Multibeam echo-sounder – e.g. Edgetech 2200-M
- Seabed/ice properties in a swath beneath or above the AUV;
- Swaths combined digitally - mosaic image of the seabed bathymetry;
- Mapping from a minimum depth of 3m below the transducers up to 350-400m;
- Steep slopes off Nice in the Mediterranean (IFREMER, 2005/6).

Sub-bottom profiler

- seabed composition – water content; grain size
- In-fauna species

Multibeam; sub-bottom profiler and side scan system - Hugin AUV (Lee & George 2004) to map the Sigsbee Escarpment in the Gulf of Mexico in depths up to 2000m.


Comparison of EM2000 with EM300 from surface ship
IFREMER survey using AsterX – raw data
Slide prepared by Dr. Vincent Rigaud - IFREMER
50-100
100-200
200-500

Mass spectrometer trials

- Sea trials done February 2002 - M.Eng. student Vanessa Pennell
- Used existing ISE “ARCS” AUV
- Underwater mass spectrometer “In-Spectr” & compact CTD
- Detection of a plume from a deposited tracer chemical
- Test of the AUV and instrument capability in preparation for offshore trials

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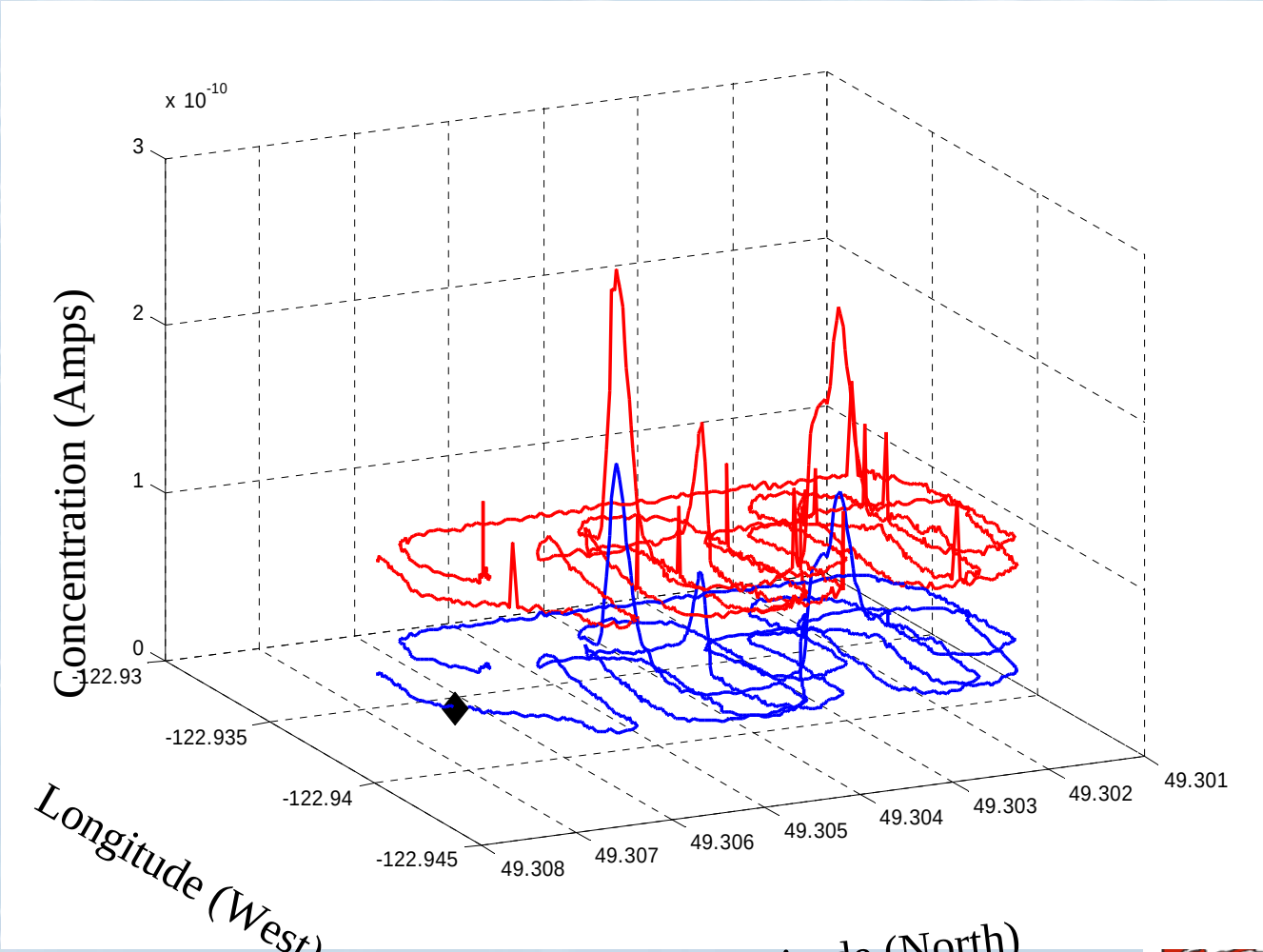
Capability - In-Spectr Data in AUV Path. 06/02/02



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Personnel

Who, how many and where to recruit?

Skills and education:

- organizational;
- operational;
- technical (hardware/software; mechanical/electrical);
- safety/recovery

Training

Management structure

Salary, etc.

Willingness to work at sea + hazardous environments

Photo: IFREMER

Funding

Capital: initial and upgrades

Operating

- Transport to site
- Ship or shore based
- Support craft
- Location of missions

Maintenance and repairs

Charge out – AUV (approx./day)

- 5,000 Euro IFREMER
- 8,700 pounds AUTOSUB
- Can.$10,000 MUN

Photo: ISE

Insurance

AUV insurers (Leviathan and brokers such as Willis, Waveney)

Presently 6-20% of capital cost per year approx., but more in high risk situations

Co-insurance; deductibles

Self insurance – is it realistic?

- What are the risks; can it be recovered if lost?
- Funding pool
- Recovery - divers and ROVs
- Procedures and protocols – operations manuals; dogmas
- Minor repairs
- Expendable AUVs

Liability

Loss in transit

Damage vs partial or total loss

Safety/operation

To AUV:

- Loss, location/positioning and recovery
- Damage during launch and recovery

To others:

- Collisions
- Operating protocols
- Regulations
- Operating personnel – safety procedures; hazardous environments (gun use; surface ice survival; etc.)
- Support vessels
- Legal aspects of operations and missions

Discussion

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In-Spectr

AML Underwater Mass Spectrometer

- Membrane Induction
- Univ. of S. Florida

Continuous vs. Non-Continuous Sampling

- dissolved gases and VOCs

138 cm by 19 cm

Almost neutrally buoyant